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SOME PRACTICAL FACTS ABOUT BEACH EROSION IN FLORIDA

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WATERWAYS DIVISION

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SOME PRACTICAL FACTS ABOUT BEACH EROSION IN FLORIDA

Morris N. Lipp

Introduction

Erosion is one of the destructive forces of nature, which like other such forces, has come to be understood by men. The particular type of erosion - beach erosion - with which this paper is concerned, has been studied and experimented with until certain governing theories and principles have been evolved. The application of these theories and principles to the design of shore protective installations has proved practical to an extent that most problems of beach erosion may be mitigated or corrected by pre-determined and readily understood means. So, in any problem of beach erosion there is on one hand, the conditions of nature, prevailing winds and tides, inlets, protuberances, etc., which cause the erosion, and on the other hand are man-made works such as groynes, bulkheads, fillings or dredgings, which may be used to cure the erosive effect.

The problems are generally involved with many variables and ramifications. Economic factors materially affect solutions. A poor approach can cause waste, an accurate one will create wealth.

The photographs submitted with this paper are illustrative of some of the matters discussed.

Formation Of Beaches

Florida has approximately seven hundred miles of sand beaches on its Atlantic and Gulf coasts. They consist generally of a mixture of silica and shell. The silica originated in the Piedmont and Appalachian mountain regions of the Southeastern States, were carried to the seas by the various rivers and then transported southward by shore currents. The shell originated in the offshore coral coastal regions. Along the northern shores the quantity of shell is negligible. It increases in quantity to the south. Although the littoral currents follow the wind direction and the prevailing winds are southerly, those from the north are more intense and move larger quantities of sand.

Other factors demonstrating the origin and movement of sand are as follows:

1. Lack of inland sand deposits in South Florida
2. Extremely slow currents in the South Florida rivers and drainage canals.
3. The phenomena of accretion to the north and erosion to the south of jetties.
4. The more extensive sand beaches and uplands of North Florida.

Prior to the dredging of channels at inlets and the construction of jetties and other man-made structures along the Florida coastline, the general trend of the beaches was towards accretion. Naturally there were periods when storms would suddenly force recession of portions of the shoreline, but the trend over long periods was towards expansion of the beaches. It must be recognized that in many instances accretion occurs in a fluctuating manner,

the shoreline advancing then receding with its next advance generally exceeding its previous limits.

Causes Of Erosion

However, when channels were excavated and jetties constructed, the free uninterrupted movement of sand to the south was impeded. Erosion, which resulted from this interruption of the littoral drift, began to occur at various places. It was merely the phenomenon of sand continuing to move south from a given area and insufficient sand moving in from the north to replace it.

As newer channels were excavated and existing ones deepened erosion was aggravated.

Besides this form of erosion resulting from the effects of the littoral drift, there is another type which should be considered. It is the result of direct attack on the shoreline by severe waves, which violently throw the sand from the foreshore to the uplands, and in some instances breach the uplands. This type of erosion is not as severe on the west coast of Florida as on the east coast, as evidenced by the comparatively lower elevation of the uplands and the existence of swales along the shoreline of the west coast.

The swales evidently represent previous shorelines. As the shoreline proceeded westerly during the long periods of accretion, storms were of insufficient intensity to move the sand from the newly formed ridges into the swales.

Effect Of Inlets

Inlets may be classified by two categories. One is the type protected by jetties and the other that without jetties.

At jetty protected inlets the southward drift of the sand is impeded by the north jetty with accretion on the north side as the logical result. Since insufficient sand will cross an inlet to replace sand moving south from its south side, erosion naturally occurs on that side of the inlet.

Of the limited quantity of sand which passes around the end of the north jetty, some is deposited in the channel, some carried into the Bay by the tides where it is deposited in the areas of slow velocity, and some is carried south and either deposited near the mouth of the inlet or on the opposite shore. A small percentage of the sand which is deposited in the Bay is carried back to the beach front by outgoing tides.

In many respects the influences and results are different at an inlet which does not have jetties.

After an inlet is first formed either by nature or man, erosion commences on the south side as a result of the inability of sand to cross the channel.

As time passes not only the channel tends to become shallower, but also the offshore waters in the vicinity of the inlet. Increasing quantities of sand then cross the inlet for initial deposition on the south side.

Some of the sand is carried directly across, whereas the large quantities which are forced offshore move to the south side of the channel where a bar is formed. Wave action then carries the material from the bar to the shore with the result that accretion occurs on the initially eroded south side.

To properly analyze the next trend of the sand after it has been deposited at an inlet's south side, the effects not only of the littoral drift should be considered but also that of the tidal currents.

At places remote from an inlet shoreline sand movement is determined from the littoral drift only. That is, when the winds are from the north, sand

drifts to the south and vice-versa.

At an inlet tidal currents as well as littoral drift affect sand movement. When the wind is from the north, currents of the ingoing tides, since the direction is different, will tend to diminish the southerly migration. Depending on the respective current velocities there will be periods of not only complete neutralization, but also sand movement into the Bay rather than to the south.

Outgoing tides, except in the immediate vicinity of the inlet will not have a cumulative result, as their currents are rapidly dissipated when the Bay waters reach the sea.

Therefore, with the outgoing tides forcing out the increasing quantities of sand crossing the inlet from the northern approaches and the ingoing tides tending to neutralize the trend of the southerly drift, the shoreline at the south side of an inlet will then naturally move seaward.

At places the changes have been so pronounced that the land has been moving north as well as seaward and pushing the inlet channel in that direction.

However, the southerly side of an inlet without jetties must be considered unstable. It is possible for the inlet to become closed. This will result in the elimination of tidal effects and straightening of the shoreline. A cleaning of the channel will reduce the quantity of migratory sand and result in a recession of the southerly shoreline.

Future trends cannot be prophesied, as many of the influences are caused by such unpredictable forces of nature as hurricanes.

Purposes Of Beach Preservation

The problem of beach preservation resolves itself into stabilization and reclamation. It is essential that for each area, it be determined whether the objective is to maintain existing shorelines or to reclaim land lost by erosion. If reclamation is the goal, then the extent must be decided upon. It is possible that the aim might be towards stabilization for a limited number of years followed by a program of reclamation. This determination should be governed by the type of upland property, improvements thereon, the proximity of the improvements to the shoreline, and the cost of protective works. It should be recognized that in general reclamation is more expensive than stabilization.

Methods Of Beach Preservation

Beaches can be preserved by either dredging, artificial structures, or by both.

In some instances sand has been dredged from bays and lagoons on to beaches. This method generally involves pumping to stock piles at different points, and then permitting the littoral currents to carry the sand to the areas between the disposal points.

It may be placed on the beach by constant shifting of discharge ends of the pipe lines. Naturally, the latter method is somewhat more expensive.

Sand may also be transported by the construction of a sand pumping station at the north side of an inlet, pumping across and discharging it on the south side.

Both methods presuppose periodic pumping. Dredging of large quantities from the open sea would be too hazardous and expensive as rough weather would interrupt the work and sudden storms destroy valuable equipment.

Artifical structures consist of bulkheads and groynes. Generally a combination of both are required. In certain instances bulkheads may be dispensed with and to a lesser degree, groynes.

Bulkheads

Bulkheads are for the purpose of retaining the uplands and acting as a final barrier against encroachment by the sea.

Where improvements are remote from a very slowly receding shoreline, bulkheads can be dispensed with, provided further tendency towards severe erosion by direct onslaught of wave action is remote. A bulkhead constructed in shallow water is less expensive than in deeper water. One constructed with groynes will be cheaper than one without groynes. Where a bulkhead lacks groynes, and is located close to the water edge, wave action will erode the sand in front and tend to undermine the wall. Furthermore, sand will not return without the aid of groynes or other accretion influences.

The top elevation of bulkheads is important. They should be high enough to prevent frequent overtopping by wave action. In this event, there will be washouts on the uplands. They should not be so high that a reasonable view of the sea will be obstructed, or the cost of filling the uplands economically unsound.

Bulkheads should be sand tight, and deep enough to provide against undermining. They should be designed to resist wave action as well as backfill pressure.

They may be constructed of timber, treated or untreated, steel sheet piling, concrete or masonry. Each type has advantages and disadvantages, not only from the standpoint of durability but of economy.

In certain instances riprap can be an effective substitute for bulkheading. Although riprap cannot be classified as perfectly sand tight, its economy can be so great that moderate periodic maintenance can more than overcome that disadvantage. It is an important principle of engineering that perfection is at many times unsound, particularly when it is too expensive, and the proper solution lies in overcoming the disadvantages of more economical structures by efficient maintenance methods.

Function Of Groynes

The main purpose of groynes is to stabilize the beach, but there will always be a slight amount of fluctuation within the stabilized area. They may also be used for reclamation to a limited degree. They function in a simple manner by interrupting the littoral drift of sand which is carried to shore by wave action. At groyne ends, however, eddies tend to form a circular area where the depth of water is greater than normal.

Because of the alternating direction of littoral drift, a good system presupposes a minimum of two groynes.

Structural Features Of Groynes

Groynes should generally have the following structural qualities:

1. Sand tightness
2. Durability against deterioration
3. Stability and flexibility against wave action.

Groynes have been constructed with different types of construction materials in various designs and fashions. In places where programs have been efficiently developed there is generally uniformity. Where there has been no planned program, a motley array exists. Groynes are generally constructed of timber, steel sheet piling, concrete, granite, and dense boulders.

The conventional type sheet piling groyne, which is supported by treated wales and piling, costs about $80.00 per linear foot on the east coast of Florida. A much better type of steel sheet piling groyne, which is supported by steel channel wales and H-piling costs approximately $100.00 per linear foot. This type has the advantage of greater strength and durability. Timber groynes, although more economical than steel sheet piling, have a shorter life because of teredo attack, even though the timbers be treated. Furthermore, they generally have less strength. Concrete groynes, although their use has been extremely limited because of their lack of flexibility would likewise be comparatively expensive. In certain localities, however, steel sheet piling groynes have failed in a short time as the result of severe sand abrasive action.

In many instances navigation channels and inlets are protected by granite jetties. Granite is durable, not subject to deterioration and dense enough to withstand damaging movement by the sea. The result is a flexible structure as movement of the granite blocks will not destroy their purpose. Therefore, it is essential that any community which has readily available granite or some similar dense rock, should consider the construction of boulder type groynes. In Florida the availability of dense rock is extremely limited but where used the cost per linear foot is about $15.00.

Length Of Groynes

Several features will determine the length of a groyne. Generally, the length of a groyne may vary from one-third to equal the spacing. The primary factors to be considered are as follows:

1. Whether the problem is stabilization, reclamation, or stabilization with future reclamation.
2. Effect on adjacent properties not provided with groynes. When littoral drift is to the south, a system of groynes will interrupt the free movement of sand, resulting in erosion in the unprotected areas to the south. The longer the groynes the greater the extent of interruption and erosive results.
3. Depth of water at ends of groynes. The deeper the water the more expensive the construction and the more difficult it is for migration of the sand moving beyond the groyne ends to other places along the beach.
4. Costs. The longer the groyne the higher the cost per unit of length for construction and maintenance.
5. Appearance. A large number of short groynes will give the beach a cluttered appearance as contrasted with a lesser number of longer groynes.
6. Spacing of Groynes. For a given length of groyne, the closer the spacing, the more effective the results.
7. Purpose of Beach. A public beach should be more expansive than a private one. The longer the groynes the better the result.
8. Nature of upland Property. Wider beaches will more effectively break waves, thereby diminishing their tendency to damage the uplands.

9. Variations in length.

It is not necessary that the groyne ends be in a uniform line. Therefore, groyne lengths may be changed to satisfy varying conditions. However, changes should be effected gradually.

Location Of Groynes

When a groyne is to be located at a street end, it is preferable that it be placed at the south line. Here it will be more effective in building up the beach and of least interference to its use.

Between street ends, groynes should preferably be placed at lot lines rather than between them.

Some Economic Considerations

In developing coastal upland areas, it must be recognized that methods of combatting erosion are generally expensive, and that the shoreline even where accretion occurs is subject to fluctuation. Therefore, crowding by building close to the shore line should be avoided unless justified economically.

Occasionally the question as to whether the uplands should be in public or private ownership is debated. In Florida private development has contributed extensively to the economic growth and wealth of the state. Yet planners must provide adequate upland property for public ownership. An equitable division by extent and location is the proper solution.

With so many miles of sand beaches, it must be admitted that economic factors will preclude the prevention of erosion at many places. At others the policy must be watchfull waiting. In areas where protective measures have been justified, much wealth has been created by properly planned programs.

Legal Problems

There are times when the engineer must coordinate the technical with the legal problems.

When the uplands are privately owned, and either erosion or an avulsion occurs, legal questions and problems sometimes arise because of the conflict of the interest of the upland owner whose title extends to the ordinary high water mark with that of the public who are entitled to the use of the foreshore, i.e., the space between the ordinary high and low water marks.

Conclusion

Generally ocean front properties are much more valuable than inland sites. At many resorts, investors have taken advantage of all of the resources of these areas. They have provided their guests with ocean and swimming pool facilities.

The demand for beach front property is ever on the increase. It is important that more durable and economical structures and methods of protection and reclamation be developed.

Fig. 1--Failure of Wing Braced Groyne at Miami Beach.

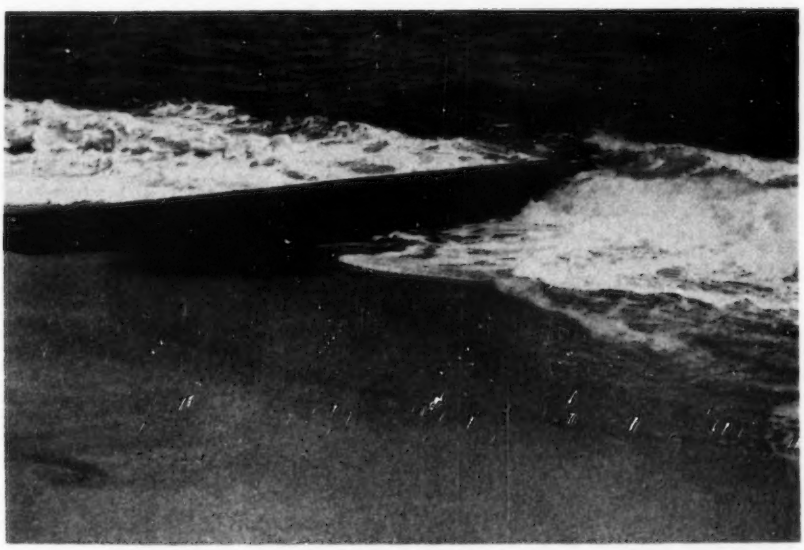

Fig. 2--Steel Groyne Encased With Timber at Boca Raton.

Fig. 3--Ocean Front South of 41st Street.

Fig. 4--Longboat Pass, Gulf Coast of Florida.

Fig. 5--Steel Groyne with Concrete Encasement to Prevent Sand Abrasion at Palm Beach.

Fig. 6--Sand Pumphouse at Boynton Inlet North Jetty.

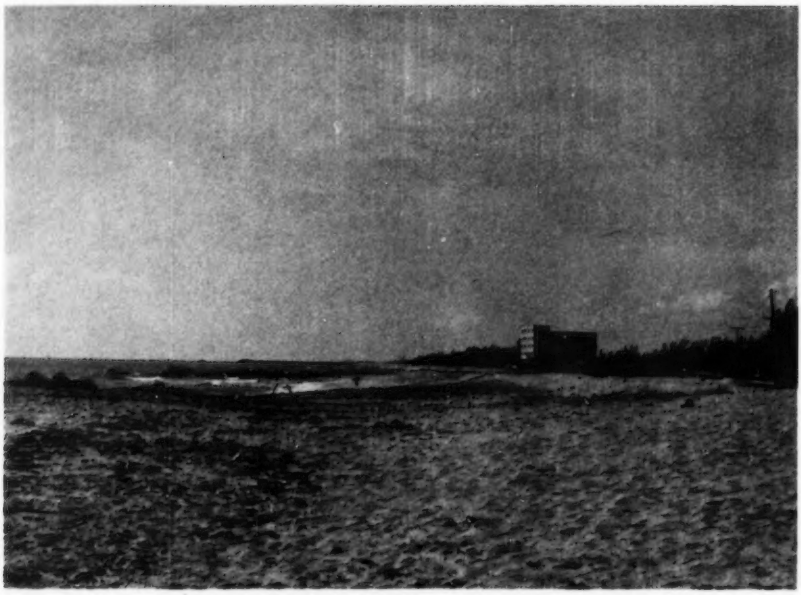

Fig. 7--Old Inlet at Fort Lauderdale Filled In by Natural Process.

Fig. 8--Sand Bank In a Bay at Boynton Inlet.

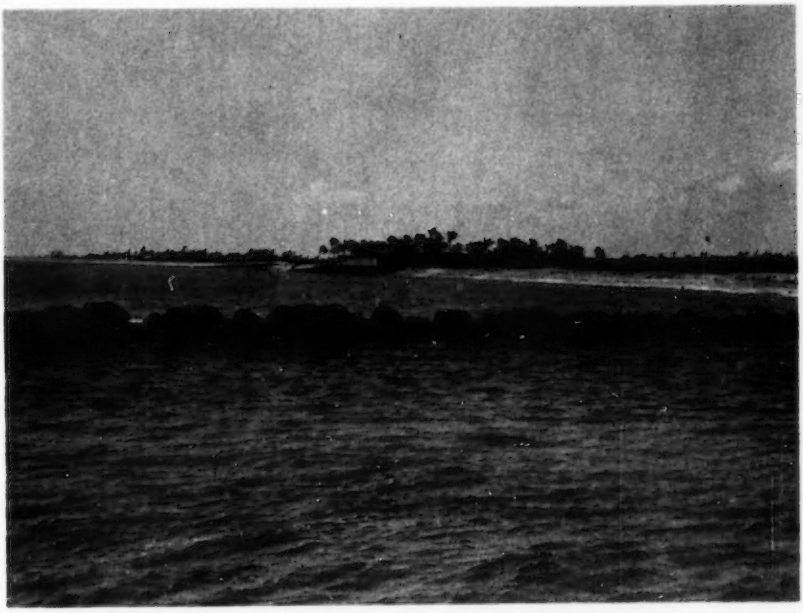

Fig. 9--Boca Raton Inlet Showing Erosion to South.

Fig. 10--Eroded Steel Groyne: Also Breakwater at Palm Beach.

Fig. 11--Accretion, North Side Boca Raton Inlet.

Fig. 12--Crowding Ocean Front at South Florida City.

Fig. 13--All Steel Groyne, Miami Beach.

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